

EXHIBIT 19

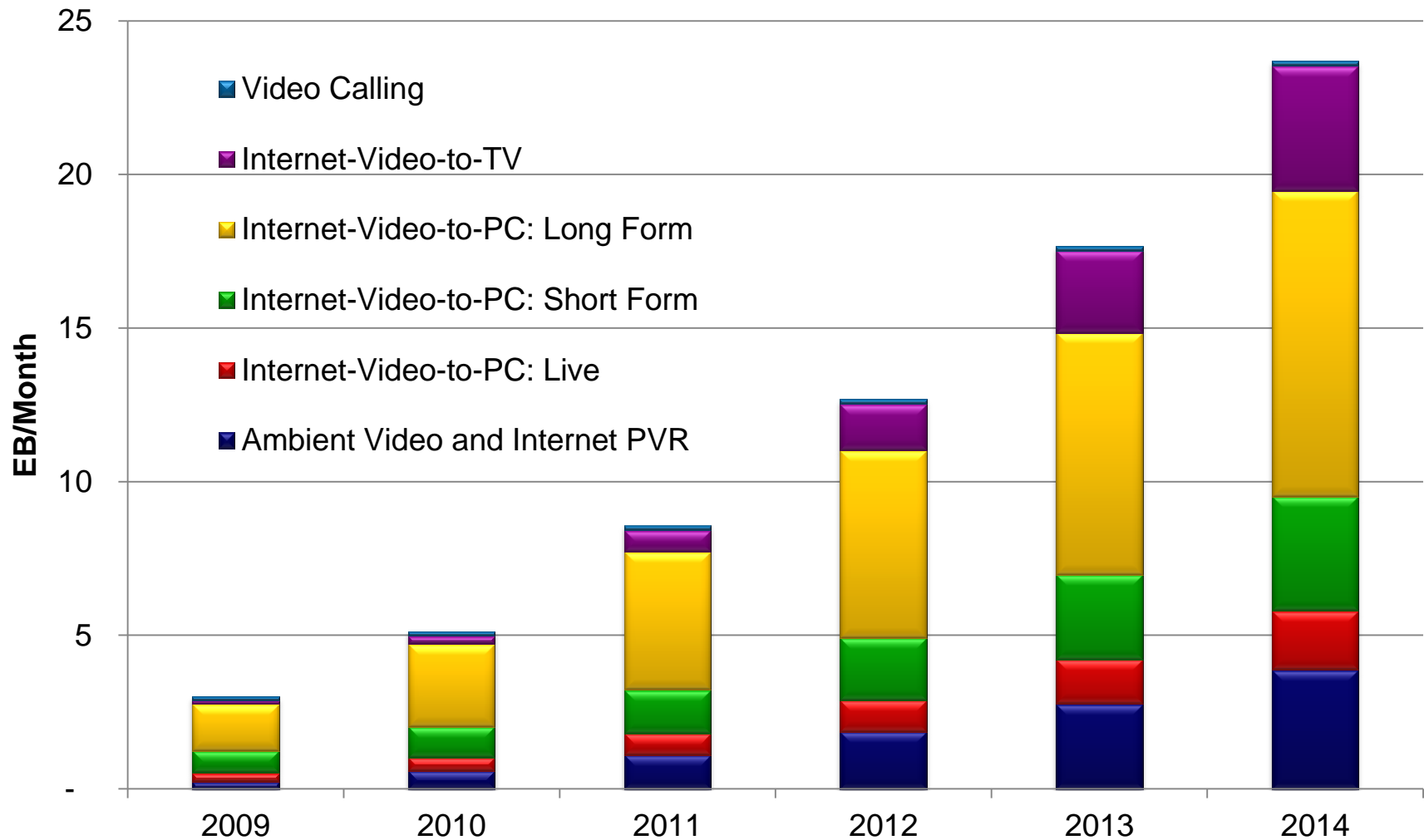


An Introduction to DASH (Dynamic Adaptive Streaming over HTTP)

Presented by Ye-Kui Wang (slides mostly by Thomas Stockhammer)

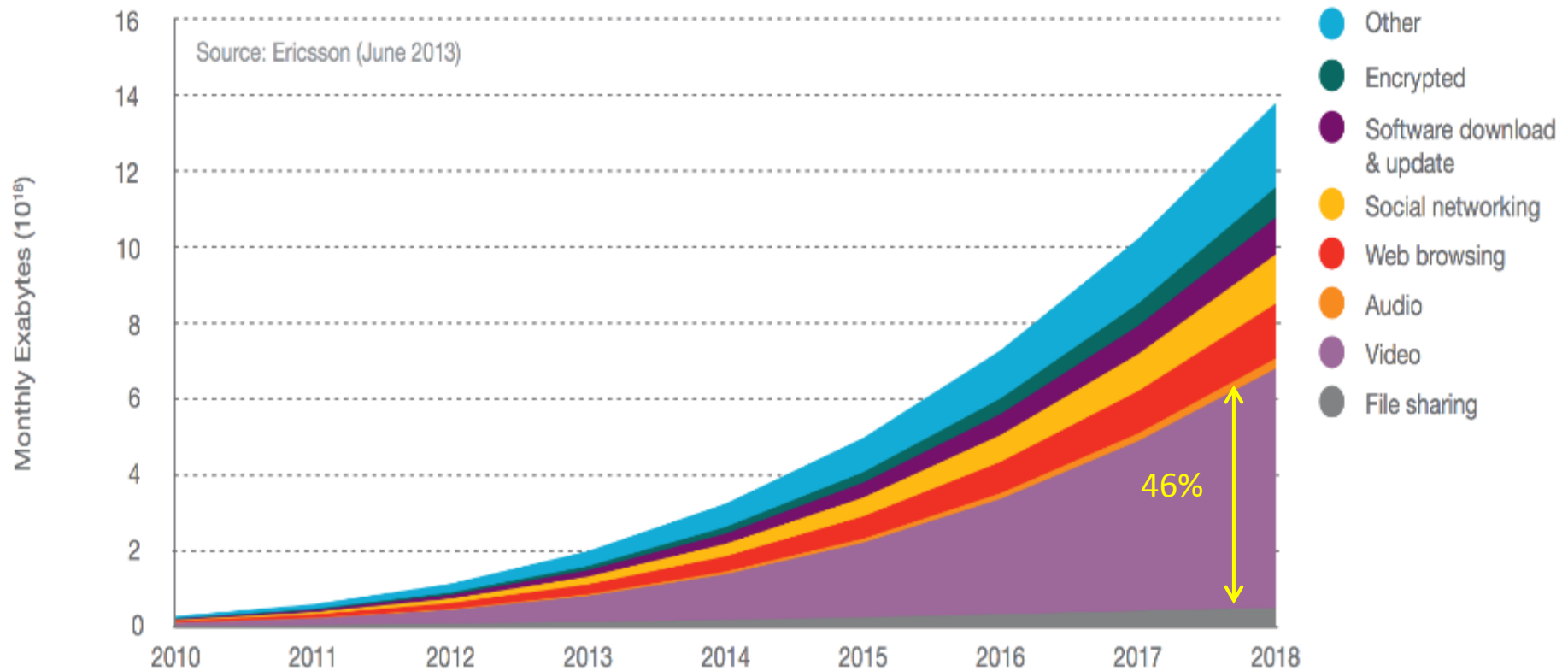
April 2015, San Diego

Motivation: Consumer Internet Video Composition



Source: <http://ciscovni.com>, EB: 1e18 bytes

Global Mobile Data Traffic

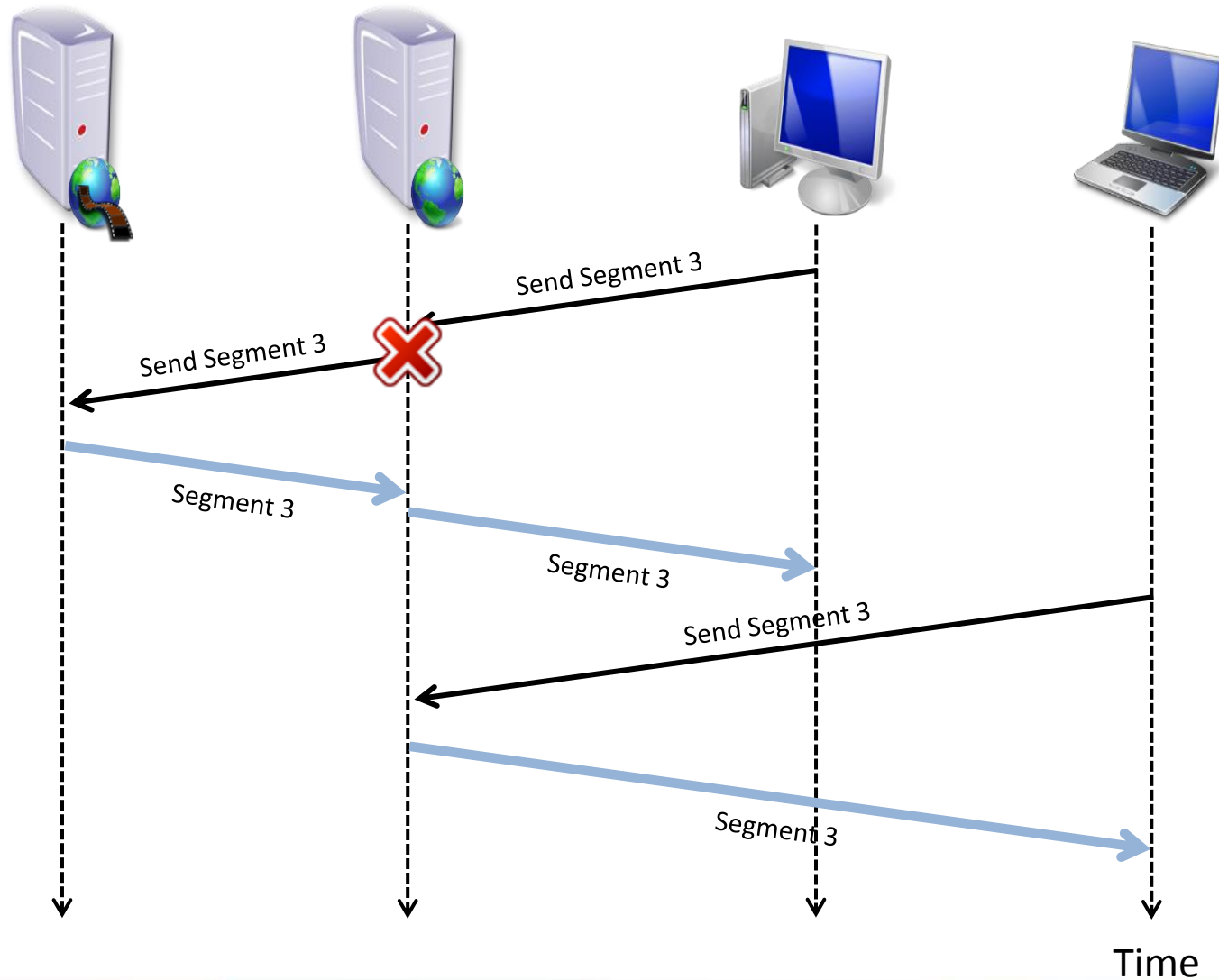


Source: <http://www.ericsson.com/mobility-report>

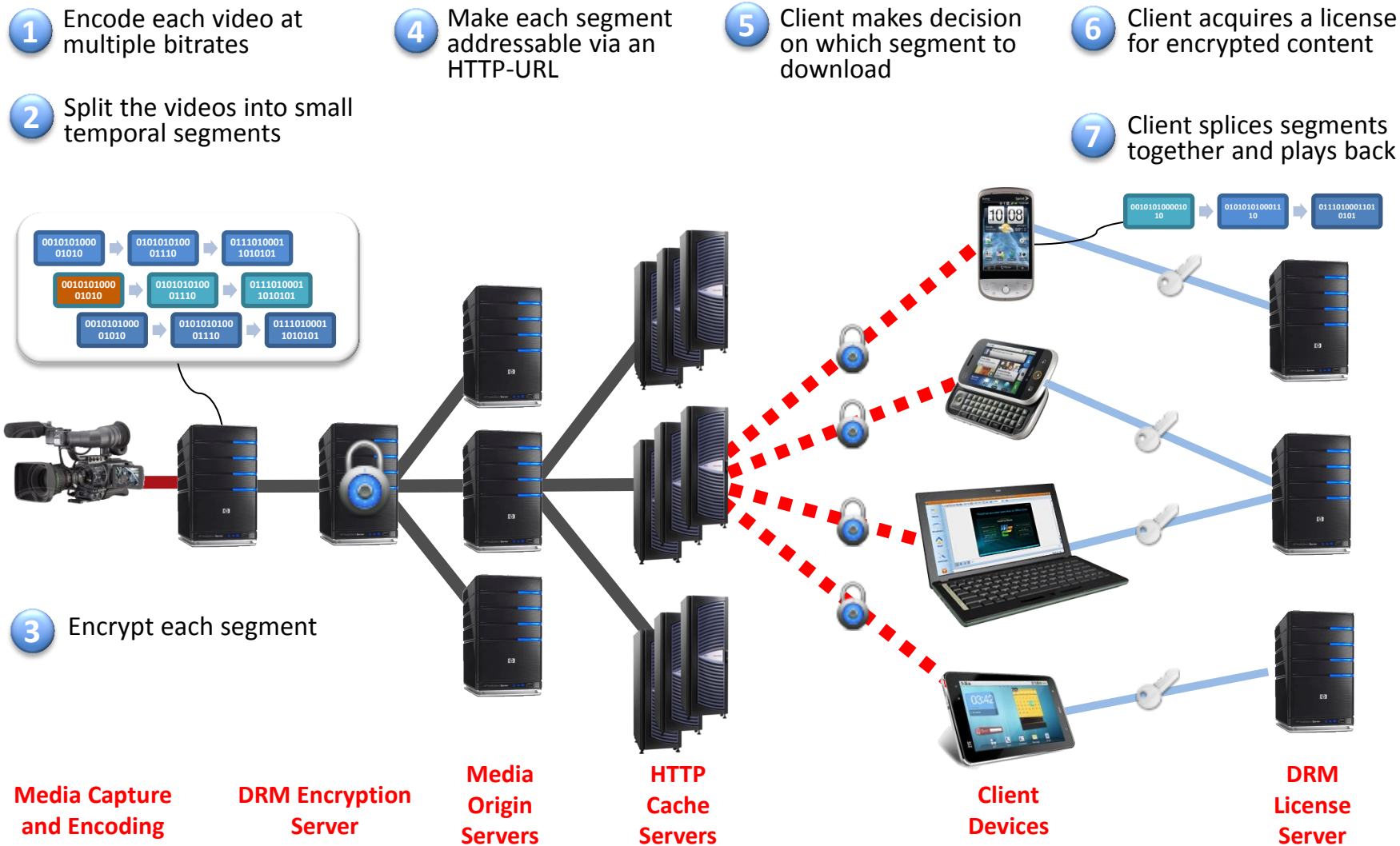
Adaptive Streaming over HTTP

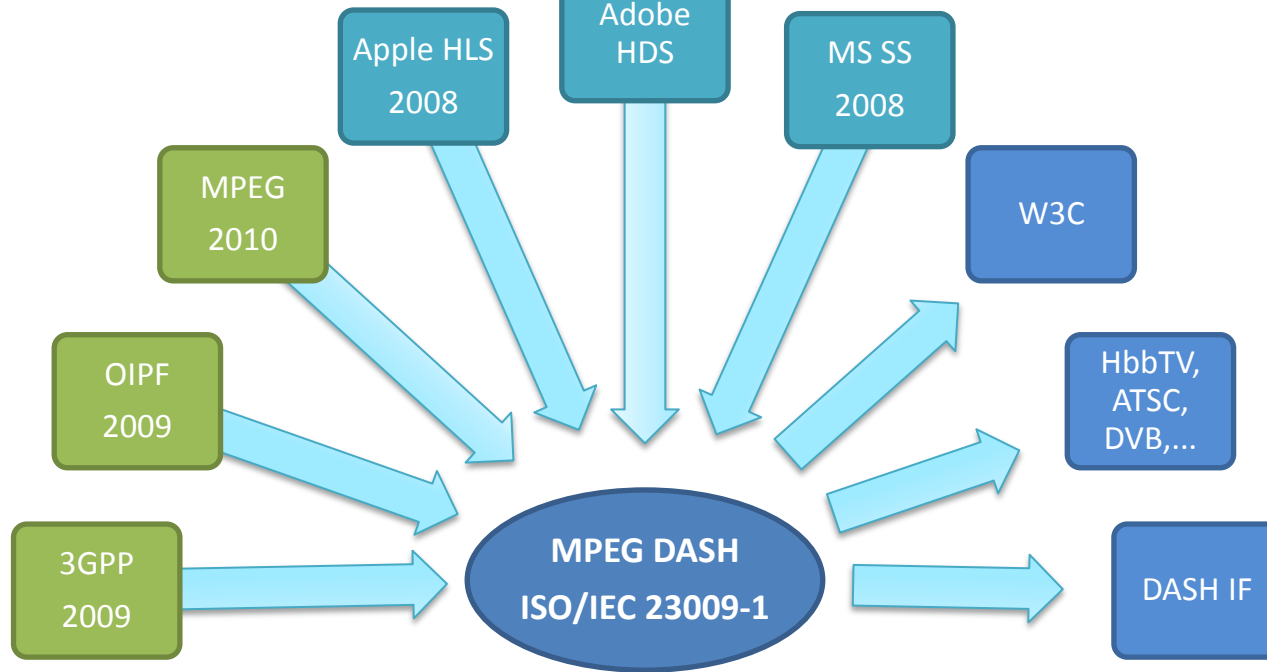
- **Basic Approach: Adapt Video to Web rather than Changing the Web**
- **Streaming realized by continuous Short Downloads**
 - Downloads in small chunks to minimize bandwidth waste
 - Enables monitoring consumption and tracking clients
- **Adaptation to Dynamic Conditions and Device Capabilities**
 - Adapts to dynamic conditions anywhere on the path through the Internet or home network
 - Adapts to display resolution, CPU and memory resources of the client
 - Facilitates “any device, anywhere, anytime” paradigm
- **Improved Quality of Experience**
 - Enables faster start-up and seeking (compared to progressive download)
 - Reduces and may eliminate rebuffering, skips, freezes and stutters
- **Use of HTTP**
 - Well-understood naming/addressing approach
 - Provides easy traversal for all kinds of middleboxes (e.g., NATs, firewalls)
 - Enables cloud access, leverages existing HTTP caching infrastructure
 - Enables client-driven deployments
 - Enables reuse of existing web technologies: authentication, authorization, etc.

Scalability and Cost: Leveraging HTTP Caches



Adaptive Streaming over HTTP – Common Understanding

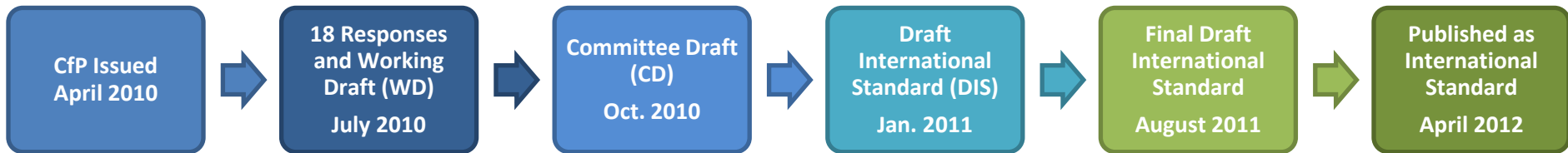




Confidence



Timeline and Standards in MPEG



Fastest time ever that a standard was developed in MPEG to address the demand of the market

- **ISO/IEC 23009 Parts**

- Part 1: Media Presentation Description and Segment Formats
- Part 2: Conformance and Reference Software
- Part 3: Implementation Guidelines

- **Other Relevant MPEG Standards**

- 14496-12: ISO Base Media File Format (ISOBMFF)
- 14496-15: Carriage of NAL unit structured video in ISOBMFF
- 23001-7: Common Encryption in ISOBMFF
- ISO/IEC 14496-30: Timed Text and other visual overlays in ISOBMFF
- Codec specs for AVC, HEVC, audio, etc.

MPEG – Dynamic Adaptive Streaming over HTTP

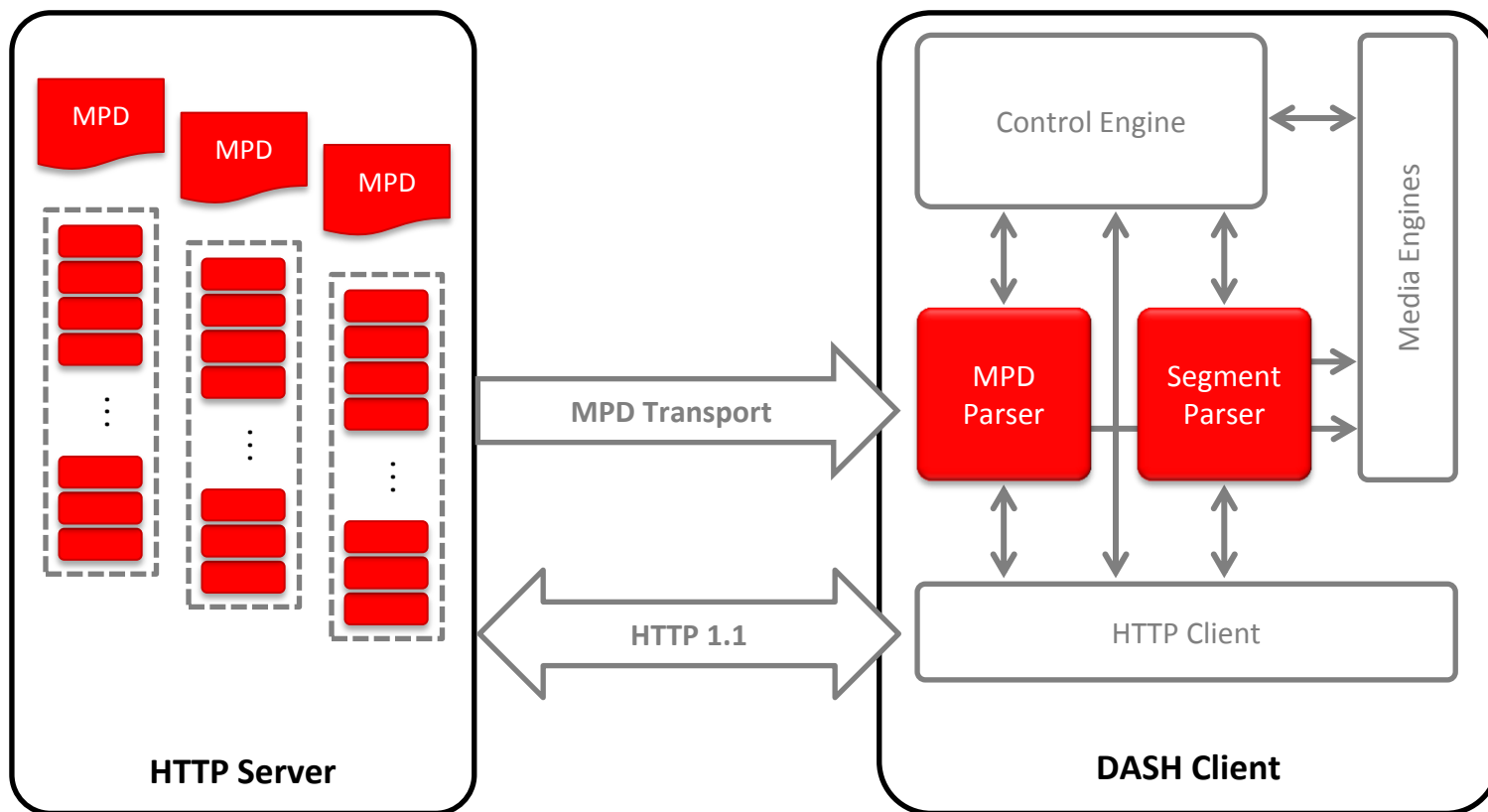
- **Goal**

- Develop an international, standardized, efficient solution for HTTP-based streaming of MPEG media

- **Major Objectives and Design Principles**

- Do the necessary, avoid the unnecessary
- Be lazy: reuse what exists in terms of codecs, formats, content protection, protocols and signaling
- Be backward-compatible (as much as possible) to enable deployments aligned with existing proprietary technologies
- Be forward-looking to provide ability to include new codecs, media types, content protection, deployment models (ad insertion, trick modes, etc.) and other relevant (or essential) metadata
- Enable efficient deployments for different use cases (live, VoD, time-shifted, etc.)
- Focus on formats describing functional properties for adaptive streaming, not on protocols or end-to-end systems or implementations
- Enable application standards and proprietary systems to create end-to-end systems based on DASH formats
- Support deployments by conformance and reference software, implementation guidelines, etc.

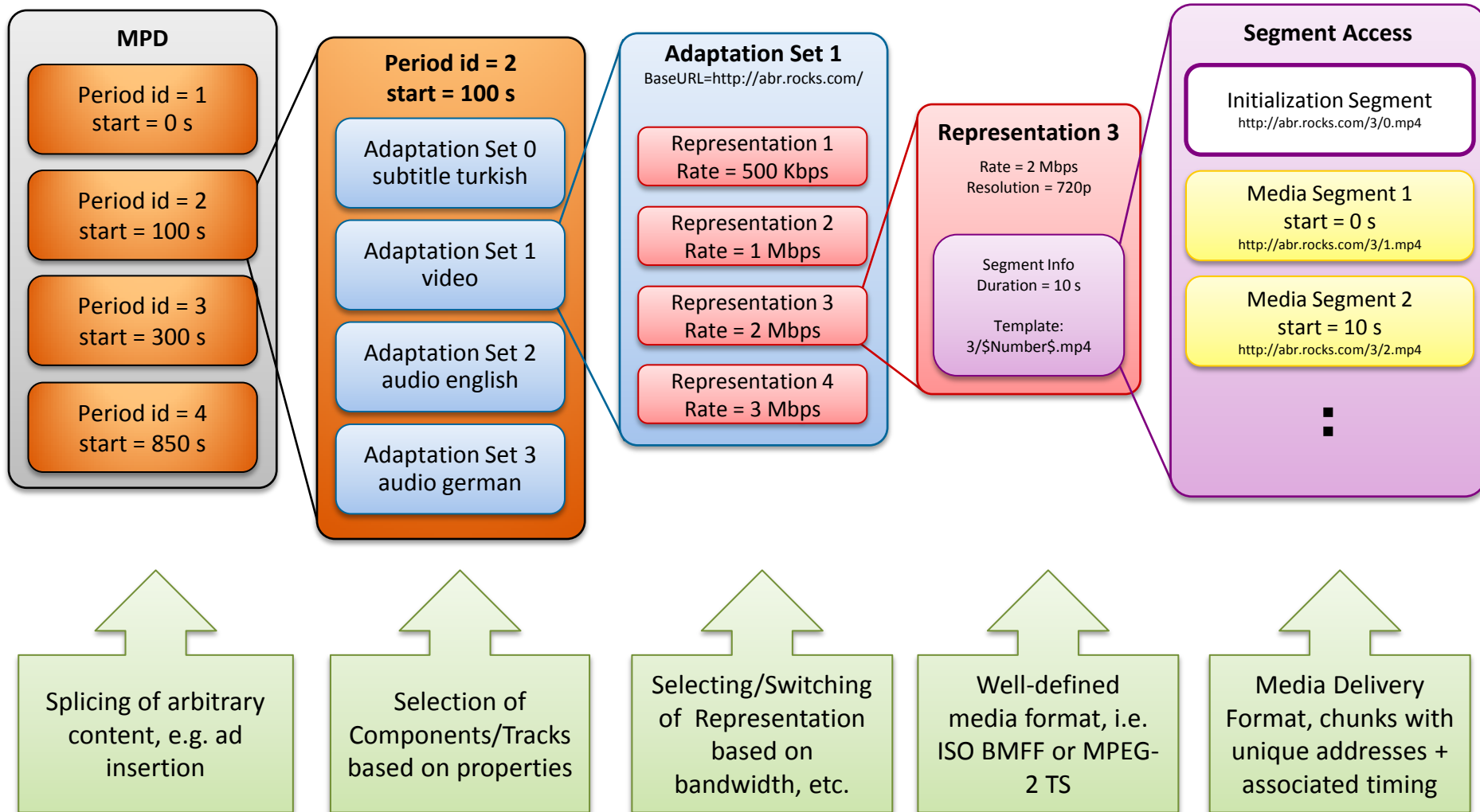
Scope of MPEG DASH (Shown in Red)



Major Functional Components (1) – Data Model

- Provide information to a client, where and when to find the data that composes A/V experience → **MPD**
- Provide the ability to offer a service on the cloud and HTTP-CDNs → **HTTP-URLs and MIME Types**
- Provide service provider the ability to combine/splice content with different properties into a single media presentation → **Periods**
- Provide service provider to enable the client/user selection of media content components based on user preferences, user interaction device profiles and capabilities, using conditions or other metadata → **Adaptation Sets**
- Provide ability to provide the same content with different encodings (bitrate, resolution, codecs) → **Representations**
- Provide extensible syntax and semantics for describing Representation and Adaptation Set properties → **Descriptors**
- Provide ability to access content in small pieces and do proper scheduling of access → **Segments and Subsegments**
- Provide ability for efficient signaling and deployment optimized addressing → **Playlist, Templates, Segment Index**
- Provide ability to enable reuse of existing encapsulation and parsing tools → **MPEG2-TS and ISO-BMFF**

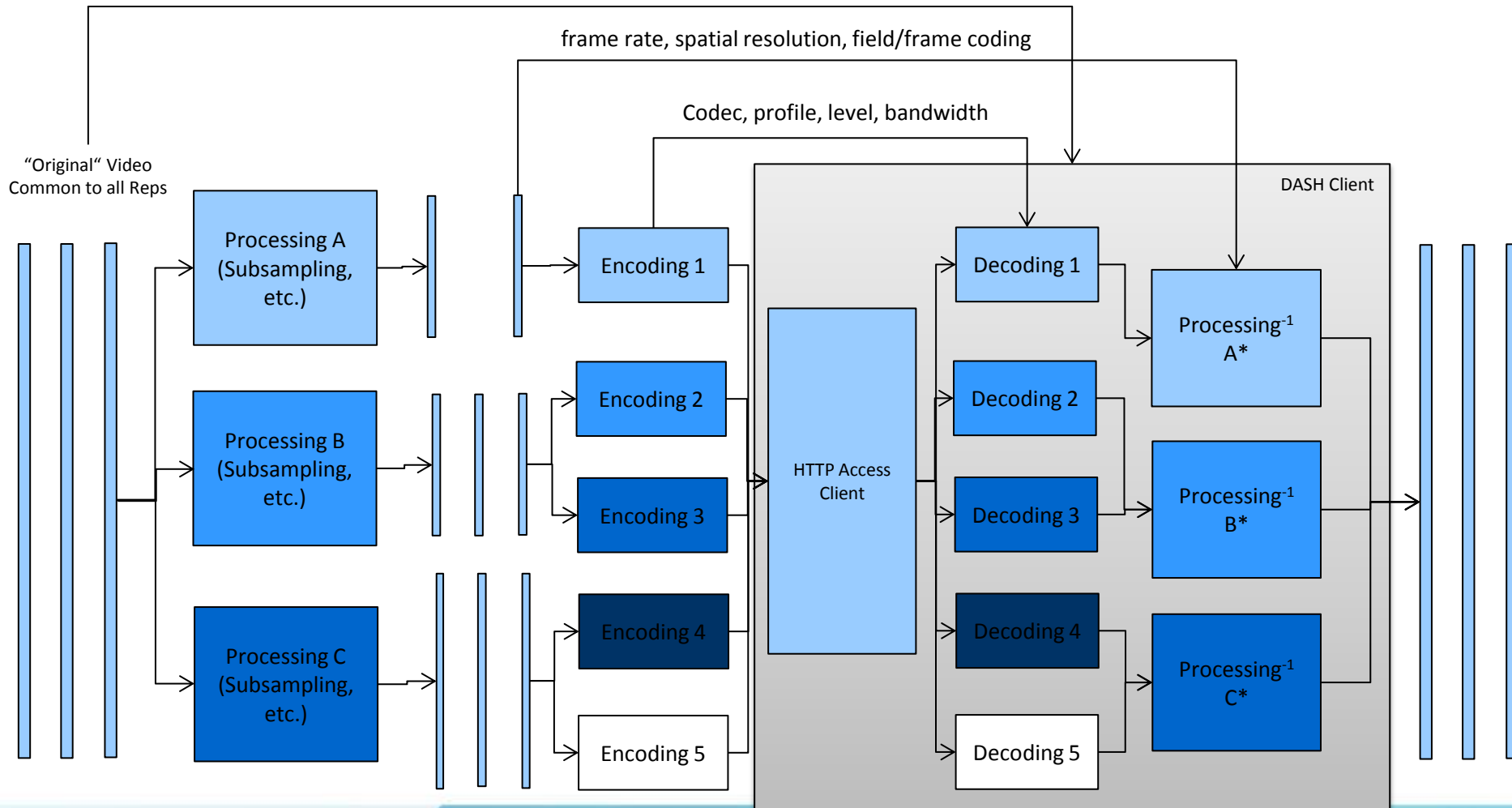
DASH Data Model



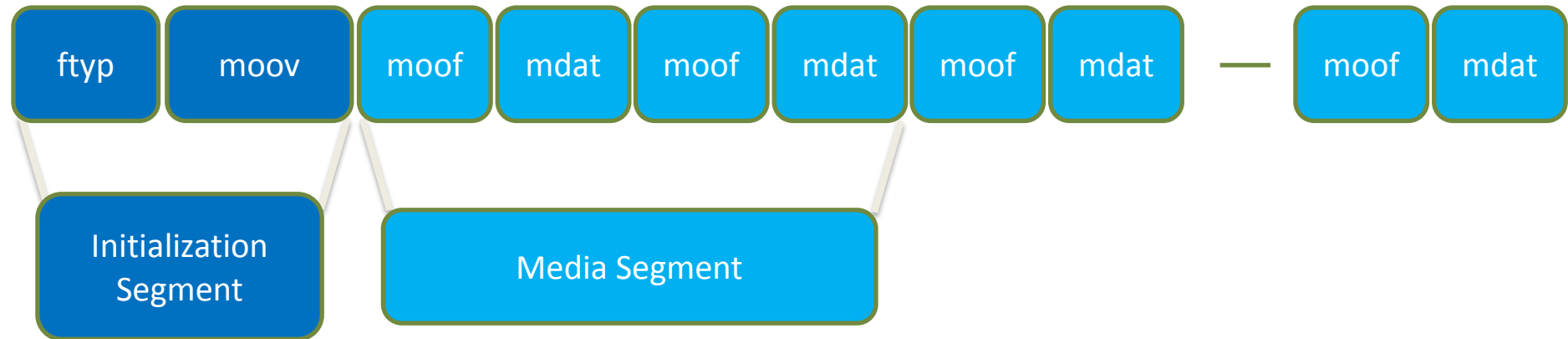
Representations in One Adaptation Set

➔ Enabling Seamless Switching

Role and Properties of each Media Component, e.g. language, main video, accessibility



Representation and Segments for ISO BMFF



- Representations are conceptual, Segments are accessible and well defined data units
- For ISO BMFF based media formats, segments are based on fragmented movie files
- Signaling per Representation in MPD
 - The type of the segment, mostly an Initialization or Media Segment
 - The URL of each media segment through explicit list or template, or byte range
 - Number template: [http://abr.rocks.com/Rep1/\\$Number\\$.mp4](http://abr.rocks.com/Rep1/$Number$.mp4) → <http://abr.rocks.com/Rep1/1.mp4>
 - Time template: [http://abr.rocks.com/Rep1/\\$Time\\$.mp4](http://abr.rocks.com/Rep1/$Time$.mp4) → <http://abr.rocks.com/Rep1/3465.mp4>
 - Segment Index & byte ranges: <http://abr.rocks.com/Rep1.mp4> → <http://abr.rocks.com/Rep1.mp4> range 3190-8959
 - The (approximate) start time and duration of each media segment (for seeking)
 - Start with SAP indication: Indicates SAP type at the start of a segment
 - The mapping of the internal movie time to the global media presentation timeline
 - The segment availability times for dynamic services

Major Functional Components (2) - Timing

- **Common Media Presentation Time**
 - Provide ability to present content from different adaptation sets synchronously
 - Provide ability to support seamless switching across different representations
- **Switching Support features**
 - Signalling of Stream Access Points
 - Segment Alignment to avoid overlap downloading and decoding
- **Play-out and decode times per Segment and Track fragment**
 - Provide ability to randomly access and seek in the content
- **Segment Availability Time**
 - Mapped to wall-clock time
 - Expresses when a segment becomes available on the server and when ceases it to be available
 - Provide ability to support live and time-shift buffer services with content generated/removed on the fly

Major Functional Components (3) - Operations

- Provide ability for personalized access to media presentation, e.g. targeted advertisement → **MPD Assembly with xlink**
- Provide ability to provide redundant content offering → **Multiple Base URLs**
- Provide ability to announce unforeseen/unpredictable events in live services → **MPD Updates**
- Provide ability to send events associated with media times → **Inband and MPD-based Event Messages**
- Provide the ability to log and report client actions → **DASH metrics**
- Provide ability to efficiently support trick modes → **Dedicated IDR-frame Representations and Sub-representations**
- Provide ability to signal collection of a subset/extension of tools → **Profiles and Interoperability Points**

Status of MPEG DASH in Industry

- DASH Industry Forum (<http://dashif.org>)
 - Founded in 2012 to promote and catalyze market adoption of MPEG DASH (70 members)
 - Established a mediator role among different communities: standardization organizations, interoperability groups, larger and smaller business entities, researchers, open source community, public and press
 - Successful demonstrations and events at IBC'12, MWC'13, NAB'13, ...
 - Published DASH-AVC/264 Interoperability Guidelines
 - Published draft versions of test vectors, test services, conformance software and open source reference client based HTML-5 extensions and Javascript
- Many SDOs adopt MPEG-DASH as THE technology for Internet TV
 - HbbTV, DTG, 3GPP, DLNA, ATSC, OIPF, CableLabs and many more ...
- Internet Streaming Services based on DASH
 - YouTube: <http://dash-mse-test.appspot.com/dash-player.html>
 - Netflix continues to stream DASH compatible content (but does not use MPDs)
 - NAGRA and Abertis telecom launch hosted multi-screen service
 - DASH is the transport format for LTE broadcast systems
 - Samsung and Orange announced to deploy DASH and HEVC
 - ...

DASH Related Standardization Activities in Different SDOs

- MPEG → bug fixing & some core experiments
- 3GPP → lots of work on DASH over eMBMS/LTE Broadcast
- DVB → defining a toolset for broadcasters to deploy their services with DASH over the top (mostly HbbTV context)
- ATSC, SCTE → deploying OTT/Hybrid based on DASH
- DASH-IF → create and demonstrate functionalities and interoperability
- W3C → browser integration
- IETF → delivery optimizations: CDNI, HTTP2.0, Multicast

Ongoing Work on DASH in MPEG

- Recurring work: Corrigenda, Conformance, Guidelines, integration of new codecs
- Amendment of Second Edition on the way to support
 - Improved live services and robustness
 - Profile for Ad Insertion
- Specific topics currently under work
 - Descriptor for Spatial Relationship in DASH (SRD)
 - Server and Network assisted DASH Operation (SAND)
 - DASH Client Authentication, Content Access Authorization, Controlling the Client Behavior
 - Quality-based streaming
 - DASH over emerging protocols HTTP/2.0 and web sockets
 - SAP-Independent Segment Signalling (SISSI)
 - Content aggregation and playback control (CAPCO)
 - ...